Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

DARWINISM AND EXPERIMENTATION IN BOTANY.

Synopsis of a Lecture before the Academy by Dr. D. T. MacDougal, Director of Laboratories, New York Botanical Garden.

A SURVEY of the present-day activities in any field of natural science would afford but meager data by the aid of which the actual trend of biological thought might be recognized, the most efficient methods of advance be determined, or research effort directed with certainty to the exploitation of the phenomena of living things offering the most immediate promise of widening human knowledge. Conceptions of this character may be gained only by the alignment in perspective of past achievements, or by noting landmarks along the devious way followed in the trial and error method by which practically all we know has been acquired.

It will be profitable, therefore, to focus attention upon the particular phase of development of biological science characterized by the establishment of the theory of descent and the full presentation of the inclusive generalizations of Darwin, especially with regard to natural selection, since the period in which this occurred was one in which a rapid and notable change in the prevailing attitude of the human mind toward natural phenomena took place.

Previous to the appearance of "The Origin of Species," and to the opening of limitless fields of research by efforts of Darwin, Julius von Sach's scholars were busily engaged in recording meager facts, in "interpreting the face of nature," the making of didactic comment taking the place of establishing relations between cause and effect, Dutrochet being the only physiologist whose efforts in this period are worthy of mention. Now, simple results of observations not in sequence, no matter whether concerned with the outline or minutiæ of leaf structure, flower detail, vascular anatomy, chromatin structure, chromosome involution, seasonal activity, or geographical distribution, do not give at first hand results of much appreciable value; whatever importance may accrue to data thus secured will be due to the manner in which they may be collocated. Properly carried out, this may reveal some forms of relativity, and forge the link between cause and effect in certain phases of biology. This may be rarely done effectively, however, and as long ago as recognized by Agassiz, it is peculiarly subject to the danger that comes from the investigator imposing his own ideas upon nature, of making colligations of the most unrelated facts, and of wandering into speculations either unjustifiable or absurd. Inclusive, orderly and corrected results of pure observations in the hands of a master may indeed yield a rich harvest of well-grounded generalizations, as evinced by "The Origin of Species" and the derived theory of natural selection.

No greater tribute could be paid to Darwin than to recognize that the inexorable logic of his own mental processes quickly carried him into the ways of the experimentalists, and no sooner had his interest been fastened upon certain phenomena than he began to arrange cultures, comparative trials and experiments dealing with many important problems in physiology, and bearing upon almost every phase of heredity and descent, and he assiduously set about their execution while the greater number of his followers were still engaged in a conflict of words and a maze of phrase construction.

The interrupted task of bringing evolution within the scope of experimental science so fairly begun by Darwin has been most forcefully completed by DeVries. Like Darwin, his well-considered results obtained by twenty years of experimental cultures have been brought out with a new theory for the interpretation of certain phases of evolutionary development. Without appraisement of the importance of mutation as a factor in evolutionary procedure, it is to be said that the greater service performed by DeVries consisted in his demonstration that the method of trial and test is one by which major phenomena in heredity may be apprehended, their course, frequency and scope measured, and by operations of so simple a nature that it has enormously stimulated research upon the subjects concerned.

The general procedure by which we experiment with functional features of organisms, or their ontogenetic or morphogenetic development, is too well known to need detailed explication. It consists essentially in setting the organism into action and calibrating the products, whether these be movements, chemical structures, tissue formations, tropistic reactions, correlations, altered rhythms of reproductive departures. In all of these, developmental or evolutionary significance is of course taken into consideration.

Now if attention be wholly directed to genetics, especially in botany, it may be seen that not only have we perfected new methods of investigation but that we have used them to some effect in uncovering principles by which inheritance is governed. Allusion to some of the more important features may not be out of place.

The prerequisite in all work of this character consists in the operator or student having series of animals or plants of known lineage. Many species or forms occur in such manner in nature that no uncertainties as to ancestry or purity of strain exists, but in cases where closely related species inhabit the same area or are close neighbors, the possibilities of inter-crossing are to be taken into account. The problem awaiting the investigator may demand a pure strain, a hybrid mixture, or a collective species including two or more elementary species, races, or biotypes; but in any case, it is absolutely necessary that the nature of the immediate ancestry of the organism be definitely determined. The derivation and composition of a group having been ascertained, they and the successive generations arising from them must be grown under measurable conditions of soil and climate, and under known possibilities of hybridization, self-out- and cross-fertilization. In other words, the characters or qualities, the behavior and action of which are being tested, must be known as to their composition, purity or combination, exactly as the chemist must deal with substances of known constituency in his exacter work. This is the essence of the pedigree-culture.

It has become plainly evident that it is upon the idea of qualities or single characters that progress in research upon evolution must be based; no longer are we concerned with the origination of species, except as an easy generalization; species themselves are so diverse in their composition and aspects among plants, especially, that it might be said with justification that there are almost as many kinds of species as there are numbers of genera. Evolution concerns variations, accretions, diminutions, appearances or disappearances of qualities, and it is to these manifestations that our attention is now primarily directed, in the hope of advancing what has now become an exact science.

Having the unit character as a workable idea and with the power to manipulate examples of it in hybrids in which alternate inheritance may occur, it is obvious that widened opportunities are afforded for studies in the mechanism of heredity, especially in the fortunate instances in which the two components of a hybrid are characterized by the number, form size, or behavior of the chromosomes. Some light is also being thrown upon the problem of the physical basis of inheritance.

In a brief paraphrase of the principal ideas presented in this sketch, it is to be said that Darwinism, which has so profoundly affected human thought, and is without parallel so far as importance of conclusions and force of suggestion are taken into account, was the climax of the purely observational method of advancing knowledge. It came at a time when biological thought was ripe for a change of attitude and method of dealing with natural phenomena. Its great author, together with other leaders in biology, passed almost wholly to experimentation in the discovery, demonstration and confirmation of the principles underlying the action of the constituency of the organic world. This method was used to the fullest extent, first in physiological inquiry, in the calibration of functional performances, and was later applied to ontogenetic development and the interpretation of form, so that now even the taxonomic and phyletic generalization lean upon its results for support. Genetics, descent and heredity escaped more slowly from the domination of illusive speculations and dogmatic philosophy, but now in these, as in practically all branches of human thought, we are no longer content with casual and hazardous arrangements of facts to fit preconceived theories, with unrestrained metaphysical interpretations of nature, but demand progression by experience and the foundation of generalizations concerning evolution upon known causes, appreciable mechanisms, and movements of ascertained direction.

Extensive fields of research lie without the domain of experimentation, yet the data gleaned from them must be put to the test of comparison with results analytically obtained. In a direct study of genetics we have at our command the pedigree culture; the conception of unit characters; some facts and a practicable theory as to the mechanism of heredity and the physical basis of inheritance; a better knowledge of the nature and causes of variability, due to the use of statistical methods, with a realization of the occurrence and importance of mutations; the power of inducing certain departures by the use of compounds or climatic factors; much evidence, chiefly of a paleontological character, as to definiteness of variations; a comprehension of the relations of environic factors to germ-plasm and soma, and some important results in selection obtained from breeding operations, together representing reasonable progress in the advancement of knowledge of a subject, established by Darwin, whose own work upon it remains its greatest contribution.